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CIVIL ENGINEERS

JUNE, 1925

Featuring

Sewerage System and
Disposal Works of
Framingham, Mass.

Problems of the
Construction Industry



Vol. XII

No. 6

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JOURNAL OF THE BOSTON SOCIETY OF CIVIL ENGINEERS

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RECENT ADDITIONS TO THE SEWERAGE SYSTEM AND DISPOSAL WORKS OF FRAMINGHAM, MASS.

By F. W. HALEY,* MEMBER, BOSTON SOCIETY OF CIVIL ENGINEERS

(Presented before the Sanitary Section, March 4, 1925)

THE town of Framingham is situated about 22 miles westerly from Boston in the Sudbury River valley. The town is divided into three districts or villages, — South Framingham, being the principal business and manufacturing center; Framingham Center, mainly a residential district; and Saxonville, a village developed around the Saxonville Mills located at a water power development in the Sudbury River.

HISTORICAL

The growth of the Framingham Sewerage Works dates from 1886, at which time the selectmen of the town were appointed a committee to investigate, have surveys made and plans prepared for a system of sewers; and petition the State Legislature for right to construct the same. Chapter 403 of the Acts of 1887 authorized the town to "construct and maintain a System of Sewage Disposal" and "connect the same by sewers with the sewers of Framingham."

In February, 1888, the Boston Water Board offered to contribute \$25,000 to the cost of the proposed sewerage system in view of the protection to the water supply of Lake Cochituate afforded by its construction.

At a special town meeting held in February, 1888, the report of the engineer employed by the town, Mr. S. C. Held, who retained Mr. Phineas Ball as consultant, was accepted, and construction of the proposed system authorized, subject to the approval of the plans by the State Board of Health.

* Assistant Engineer, Barbour and Dixon, Consulting Engineers, Boston.

Briefly stated, the original plans called for the construction of about five miles of street sewers in South Framingham, three miles of which were underdrained; interception was by a 24-inch x 36-inch brick sewer laid in Waverly Street, draining by gravity to the Lokerville Pumping Station, located near the Natick town line.

After passing through a circular gate chamber which was also fitted with vertical bar screens, the sewage passed into two receiving reservoirs, each being 30 feet by 110 feet in horizontal dimensions, the floor and roof being semi-elliptical in shape. These reservoirs were connected at their lower end by a common suction well. The capacity of these receiving reservoirs is 430,000 gallons and designed to hold the sewage during the night hours, such sludge and scum as was not deposited on the bottom being pumped, along with the sewage, to the disposal plant and distributed over the surface of the beds.

The original pump capacity of the station was 2 million gallons daily. A 12-inch cast-iron force main 9,740 feet in length connected the pumping station and disposal plant, eleven 6-inch plugged branches being laid in this force main "to allow the sewage to be drawn for use as fertilizer."

The land acquired for the sewage farm had an area of about 69 acres, of which 12 acres, divided into 11 beds, were developed for "intermittent filtration," the remainder being devoted to "broad irrigation." The construction of these beds consisted of plowing and grubbing, only such loam being removed as was necessary to construct the embankments. A 6-inch underdrain, 6 feet below the surface, was laid in 6 of the beds. Distribution of the sewage over the surface was provided by plowed furrows.

Previous to the construction works described in the following paper, the sewerage system of the town had been developed to include about 27 miles of street sewers; an additional 18-inch force main from the Lokerville station to the disposal plant had been constructed; additional pumping equipment giving a total capacity of 10 million gallons daily had been provided, and the disposal field extended to 18 beds having a total area of about 21 acres. About 2,500 connections had been made, and the average daily flow for the year 1923 was about 1.3 million gallons daily.

Agitation for the construction of sewerage facilities in the villages of Framingham Center and Saxonville was started about the year 1910, at which time the town engineer was instructed to investigate and report upon a system of sewers for Framingham Center. This report and a

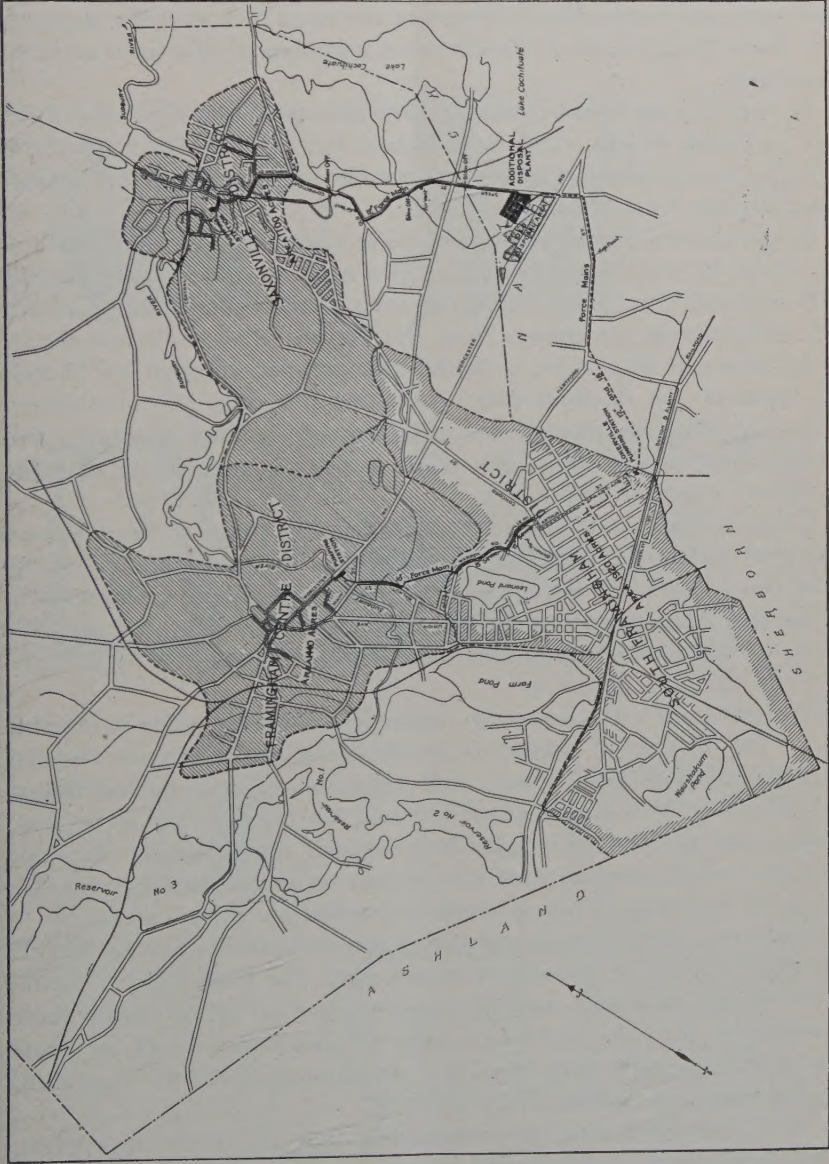


FIG. 1.— GENERAL PLAN SHOWING SEWERED AREA AND ADDITIONAL DISPOSAL PLANT

subsequent one made in 1915 covering construction of sewers for Framingham Center and Saxonville, both of which reports met with the approval of the State Department of Health, were accepted by the town and laid on the table.

In 1917, a joint board comprising the selectmen and members of the Board of Public Works, authorized Messrs. H. P. Eddy, F. A. Barbour and E. S. Larned to report upon the sewerage and the disposal of sewage of Framingham Center and Saxonville.

Briefly stated, the conclusion of these engineers was that the construction of the plan proposed by the town engineer, involving the laying of a 20-inch cast-iron sewer 19,000 feet long, in the valley of the Sudbury River and draining the sewage from the Center village to Saxonville by gravity, where it was to be collected and pumped through an 18-inch force main to the disposal plant, involved not only an unnecessary expense but that the plan of collecting sewage in large reservoirs and confining the pumping to the day hours was not in accordance with the best modern engineering practice.

It was the opinion of these engineers that the needs of Framingham Center and Saxonville could be as well served by independent systems for the two villages, the sewage of Framingham Center to be pumped to the South Framingham system and again pumped, at the Lokerville station, to the disposal area, and the Saxonville sewage to be pumped directly to the filter beds.

In connection with this report, investigations were made of possible sites for the disposal of sewage at points below the Saxonville district. Favorable locations were found, and estimates of cost for an Imhoff tank and sand filters, automatically dosed, were made. It was found, however, that the cost of independent disposal was so nearly the same as pumping to the present area that it was recommended that the disposal of all the sewage from the town be carried out at one place.

A sewerage committee appointed at a town meeting held in March, 1922, after a study of the reports made upon the Framingham Center and Saxonville problems and in consideration of all available data, recommended that the town construct the sewerage works for these districts substantially along the lines recommended by the consulting engineers mentioned above.

This committee, after recommending that the town appropriate the necessary funds to construct sewerage works in the two districts, retained Mr. F. A. Barbour as consulting engineer, and the construction outlined in the following paper resulted.

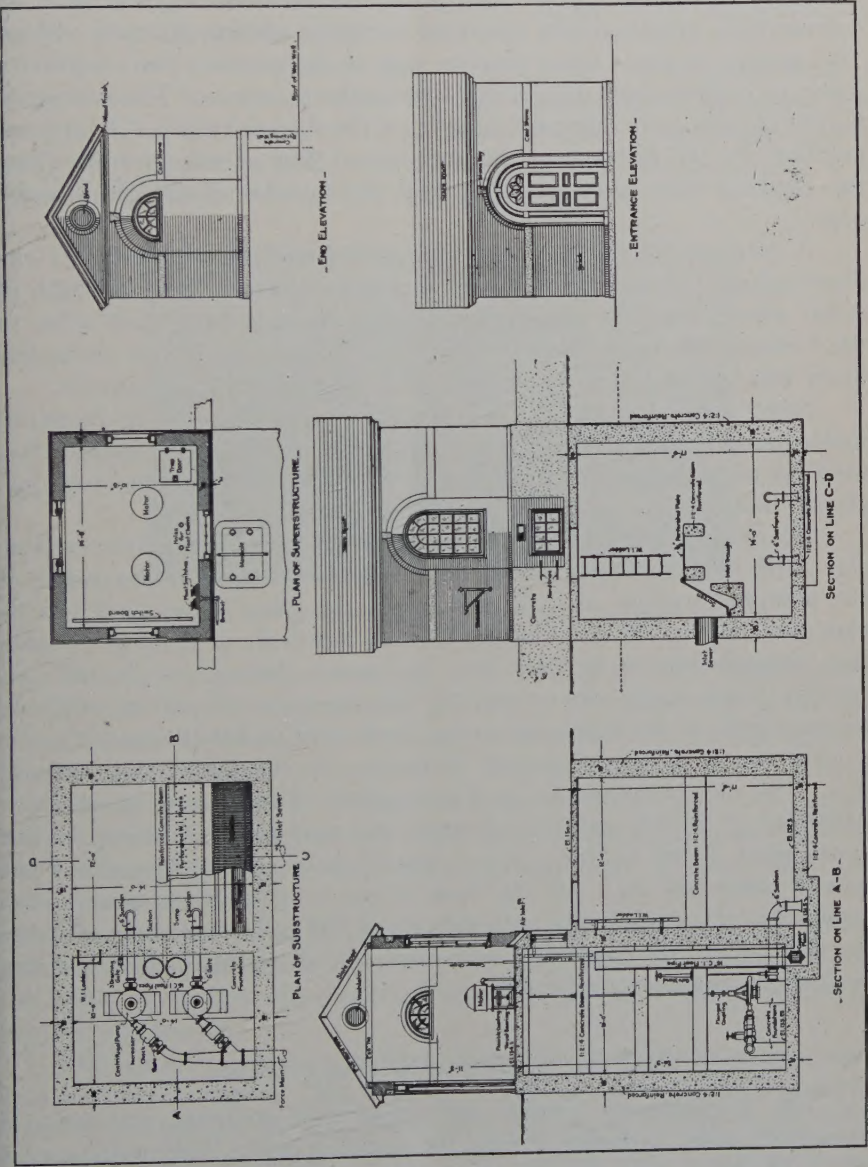


FIG. 2. — PUMPING STATION — FRAMINGHAM CENTER DISTRICT

The work contemplated called for the construction of street sewers for the Framingham Center and Saxonville districts, together with an independent, automatically operated pumping station for each village. The sewage of the Center district was to be pumped into a gravity sewer to connect with the South Framingham sewers. The sewage of Saxonville was to be pumped directly to the disposal plant. Additional facilities for the disposal of the anticipated flow of sewage from these two districts were to be provided near the location of the old disposal area.

A total of 6.4 miles of sewers was included in the design of the Framingham Center district and 4.75 miles in Saxonville, the length of street sewers actually constructed being 3.06 miles and 2.69 miles in the Center and Saxonville districts, respectively; 4,135 feet of underdrain was laid in Framingham Center and 1,870 feet in Saxonville.

Street sewers ranged in size from 6 inches to 18 inches in diameter, underdrains from 5 inches to 8 inches. All vitrified pipe, except that used for underdrains and for sewers reinforced with concrete, was purchased under A. S. T. M. specifications.

No unusual features were encountered in the construction, and as this paper is intended primarily for the presentation for discussion of the pumping stations and disposal plant, the street sewers will not be elaborated upon. It may be of interest, however, in passing, to note that observations of leakage into the sewers before any house connections were made, determined by measurement of rise of water in the wet well of the pumping station, indicated at Framingham Center a total flow of 1,550 gallons per 24 hours. At Saxonville the well was dry. The rate of infiltration at Framingham Center, based upon about 2,000 feet of 10-inch and 18-inch sewer laid near and well below the low water level in the Sudbury River, was slightly over 4,000 gallons per mile of sewer per day. On the basis of the total length of sewers constructed in this district, the rate was about 500 gallons per mile of sewer per day. Jointing compound was used for all sewers laid below the permanent ground water level.

PUMPING STATION AND FORCE MAINS

The Framingham Center and Saxonville pumping stations are practically alike in design, except for depth of well. Wet wells are 12 feet x 14 feet in plan dimensions, and are designed to hold a depth of 6 feet of sewage, or 1,260 gallons per foot of depth below invert of the

entering sewer. The dry well containing the pumps is 10 feet x 14 feet, the floor being 9 inches higher than that of the wet well to allow draining in case of accidental flooding.

There are two Midwest Hill, vertical-shaft centrifugal pumps at each station. Motors are set on the floor directly above the pumps and are controlled by float-actuated switches. A rise of the sewage in the wet well to a predetermined elevation starts the apparatus, and it is automatically stopped when the well is pumped out.



FIG. 3. — PUMPING STATION — SAXONVILLE DISTRICT

The rated capacities of pumps at the Framingham Center station are 250 and 350 gallons per minute, and driven by 7.5 and 10 h. p. motors, respectively. At Saxonville, the pumps are rated at 350 and 450 gallons per minute, and are both operated by 20 h. p. motors. The total head at Framingham Center is 38 feet, and at Saxonville, 74 feet. All motors are operated by 3-phase, 60-cycle, 220-volt alternating current. Motors are protected by inverse time-limit, overload relay switches operating a main line contactor.

The load and thrust of the shaft and pump impeller are carried by a ball-bearing thrust bearing above the floor level and directly under the motor, a flanged slip-coupling being introduced between the thrust bearing and motor.

The suction pipes are provided with gate valves, the discharge with gate and check valves. High water in the wet well places a positive head on the pumps, priming them with the rise of sewage in the well. Air release pipes are tapped-in just back of check valves to allow escape of entrapped air and insure starting of pumps with each rise of the sewage in well.

Wrought iron sloping screens, made up of $\frac{3}{4}$ -inch square bars, 12 feet long by 4 feet high, with $1\frac{3}{16}$ -inch clear opening, are placed in each station. Provision for draining the collected screened material is made by perforated plates in the screen platform.

The Framingham Center force main, 3,800 feet long, is 10 inches in diameter, and is laid on a rising grade from the pumping station to the outlet at Warren Road, at which point it discharges into a gravity

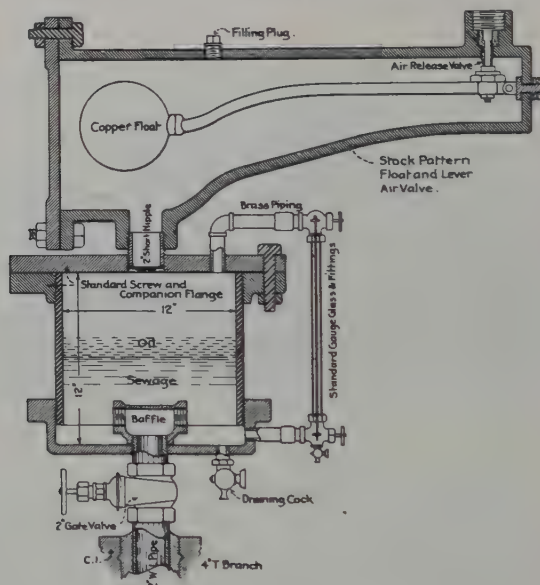


FIG. 4. — DETAILS OF AIR RELEASE APPARATUS

sewer draining to the Lokerville Pumping Station. A section of this line laid through a peat bog is supported on a pile section.

The Saxonville force main is 12 inches in diameter and 11,537 feet in length. It was impracticable to lay this line on a continuous rising grade, three summits being necessary. The principal high point is equipped with a $2\frac{1}{2}$ -inch vertical riser pipe extending above the hydraulic gradient; the other two summits are equipped with automatic air release apparatus comprising a Rensselaer air valve protected from the sewage by a specially designed oil chamber. Leadite jointing compound was used for both force mains.

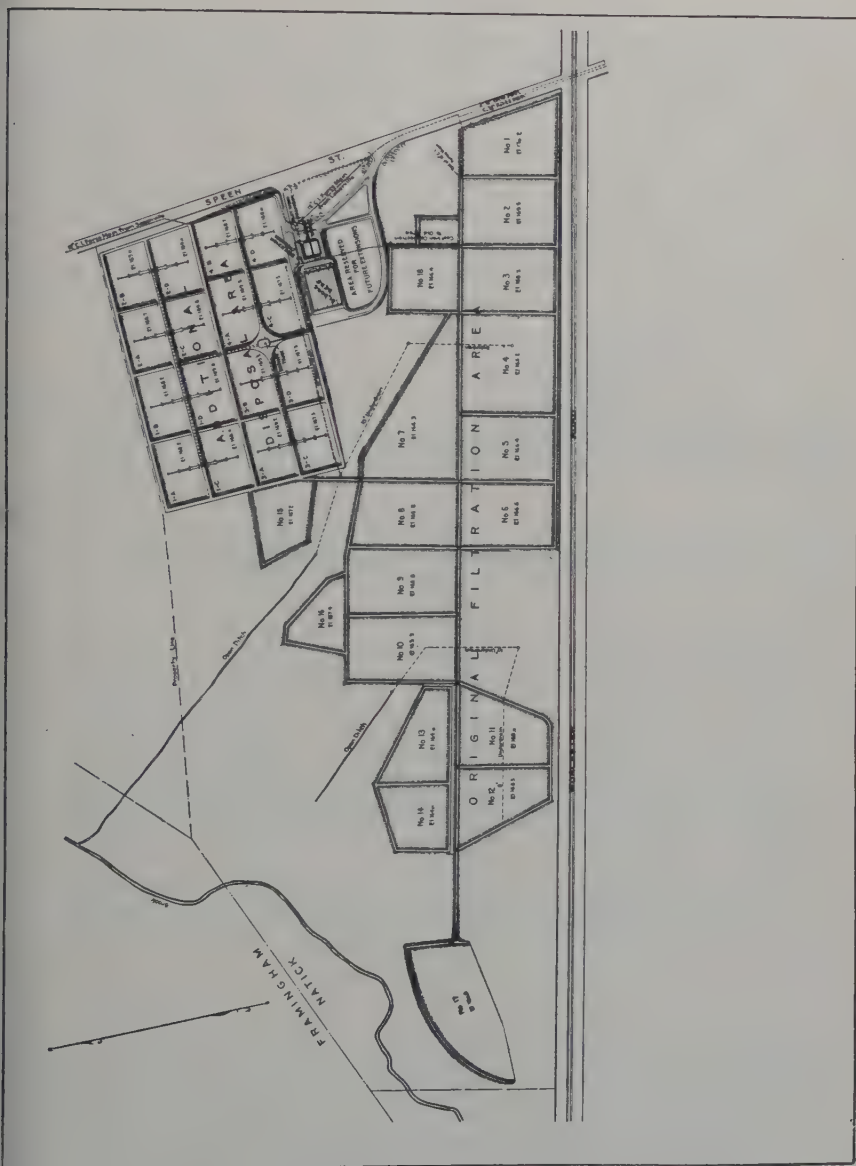


FIG. 5. — GENERAL PLAN OF DISPOSAL PLANT

ADDITIONAL DISPOSAL PLANT

The new disposal plant is located just north of the old filtration area, and consists of an inlet weir chamber, two Imhoff tanks, sludge beds, a dosing tank and 16 $\frac{1}{2}$ -acre sand filter beds. Provision for dis-

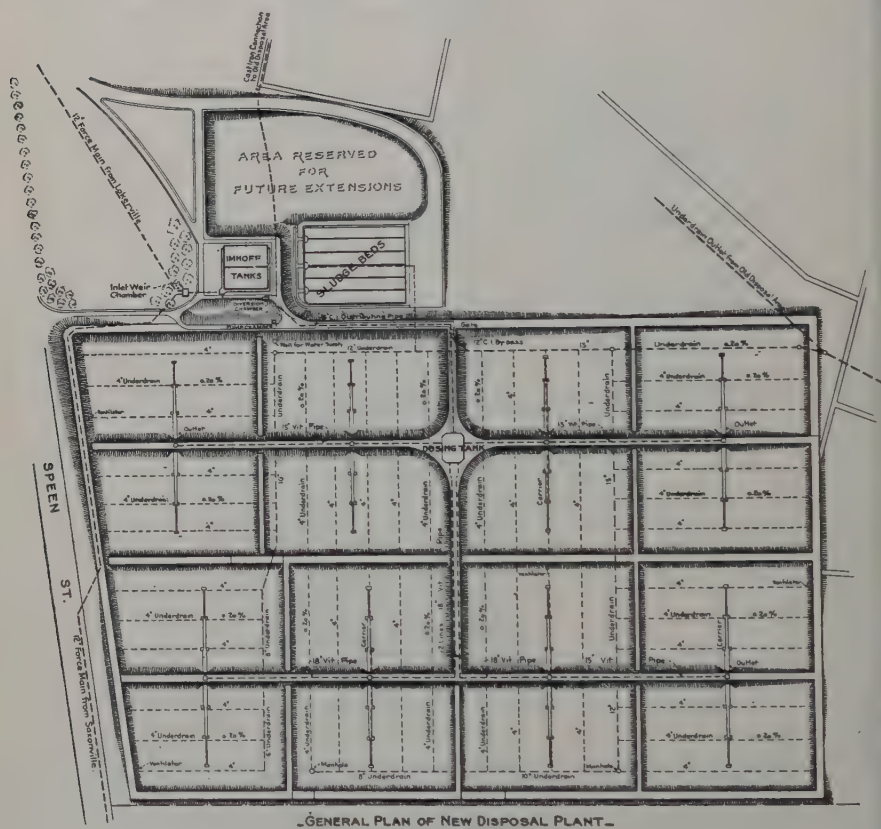


FIG. 6

charging Imhoff tank effluent to the old area has been provided by a diversion chamber cut into the connection to the sand filters.

Two cast-iron weir plates are built into the concrete structure of the weir chamber, the sewage from the Saxonville district flowing over a 24-inch weir, a 36-inch weir being provided for measuring the sewage flow from Lokerville. Provision for the installation of automatic recording apparatus has been made.

IMHOFF TANKS

The Imhoff tanks are of the rectangular, horizontal, reversible-flow type, with each unit designed to treat the sewage of 5,000 people. Each settling compartment has a volume of 6,167 cubic feet, or such as will provide a sedimentation period of three hours, with a flow of 375,000 gallons per day, and two hours and twelve minutes with a flow of 500,000 gallons per day. The tanks are designed so that by shifting stop-planks the flow can be reversed, this to insure good distribution of the sludge in the digestion chamber. The flow leaves the settling chamber over plank weirs, and cast-iron guides for interior baffles are also provided.

From the upper settling compartment the settleable solids drop through a trapped slot into the lower or digestion chamber, which in each unit has a volume of 10,063 cubic feet measured from the apexes of bottom to a level 18 inches below the slot, or 2 cubic feet per capita for 5,000 people, or sufficient to hold for six months the accumulated sludge from this number of people.

Gas vents are provided along each side and through the center of each tank, the total gas area being 21 per cent of the superficial area of the tanks.

Each digestion chamber has two inverted, pyramidal bottoms with slopes of one vertical to two horizontal, and to insure movement of the sludge in emptying the chamber, two rings of 2-inch cast-iron pipe with $\frac{1}{8}$ -inch drilled holes, spaced 18 inches on centers, connect with a water supply obtained from a well excavated in one of the adjacent filter beds. This well which collects sewage filtrate has a capacity of 2,400 gallons below underdrain level. The pumping equipment includes a $1\frac{1}{2}$ -inch Downie single stage, horizontal centrifugal pump directly connected to a 3-phase, 60-cycle, 220-volt, $7\frac{1}{2}$ h. p. General Electric motor, the outfit being controlled by a hand-starting compensator fitted with overload relay and no voltage attachment. This unit will deliver 100 gallons per minute under a head of 100 feet. Provision is made for priming by a connection with the 16-inch line from the Imhoff tank to the dosing tank. The cost of this water supply was but a fraction of that necessary to obtain an equivalent quantity and pressure from the Natick system, and the results have been entirely satisfactory to date.

Provision for discharging sludge from the digestion chambers is made by four lines of 8-inch cast-iron pipe terminating in the apexes of the four pyramidal bottoms of the digestion chamber, these pipes extending above the outside ground to an open end for cleaning.

Y branches connect with two 8-inch pipes which lead to the sludge beds in such a way that the head available for moving the sludge is not less than 6 feet. Connection is also made with the water supply for flushing the sludge pipe system. The sludge removal has been entirely satisfactory to date.

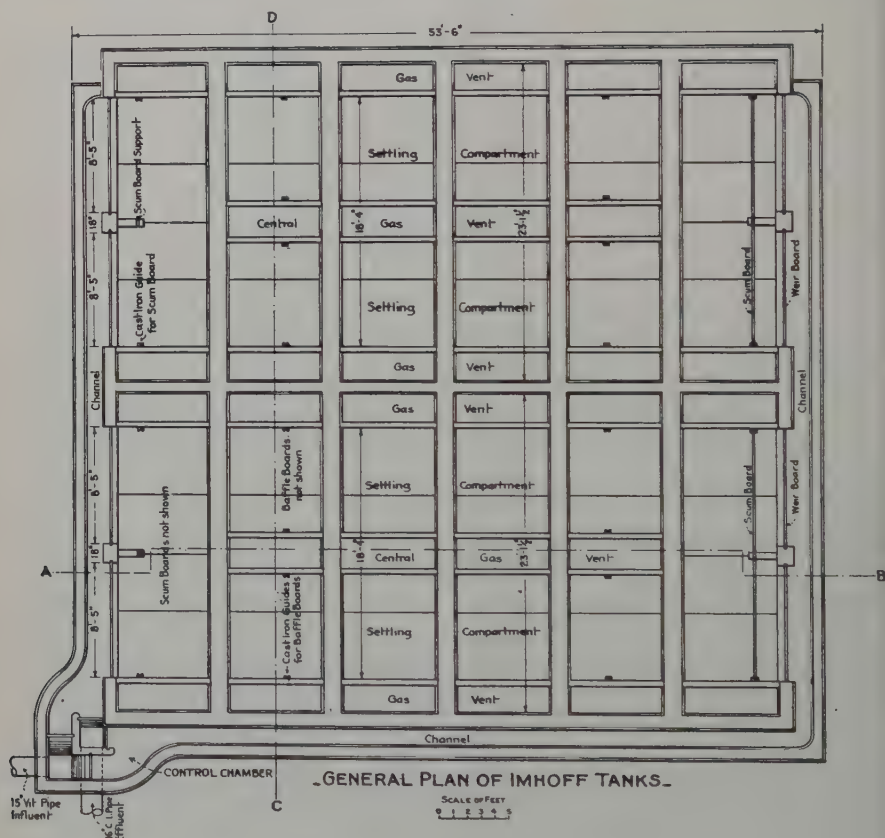


FIG. 7

(Section through Imhoff Tanks shown on opposite page)

The structure of the Imhoff tanks is reinforced concrete, a 1: 2: 4 mix being used for all except the 4-inch partition walls and the cross beams, the mix in these parts being 1: 2: 3. Aggregate used in the partition walls was not over 1 inch in greatest diameter.

The 4-inch partition-wall concrete was poured between forms, 3-inch x 3-inch x 4-inch cement mortar blocks being wired between the

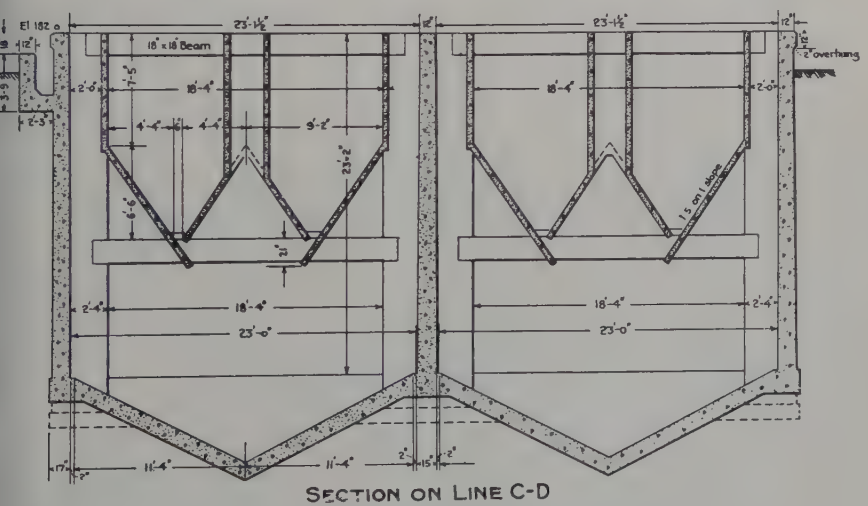
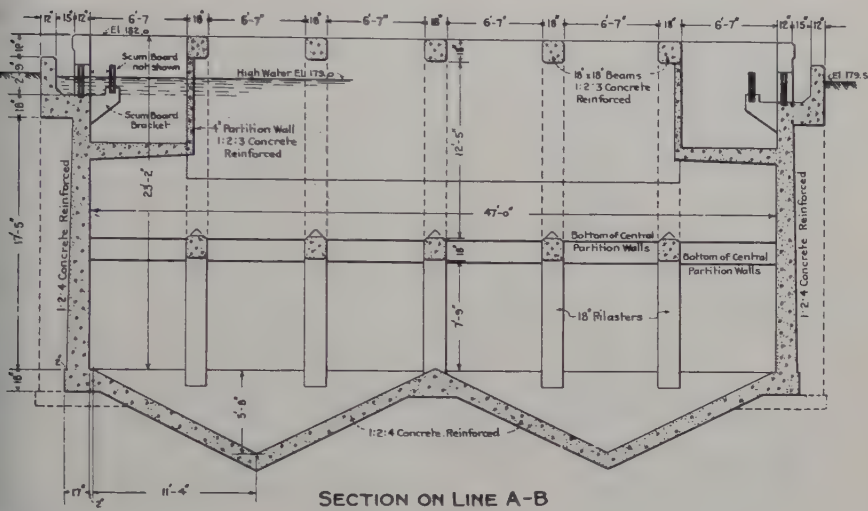


FIG. 8. — SECTIONS THROUGH IMHOFF TANKS
(Plan of Imhoff Tanks shown on opposite page)

forms to insure uniform thickness. The inverted pyramidal bottoms were constructed with top forms, this method of construction being thought better than the placing of a mortar finish on the comparatively dry concrete base which would be necessary on such a steep slope. The 18-inch cross beams are reinforced as ties, in order that additional units may be constructed without interrupting operation of the present tanks.

SLUDGE BEDS

The sludge beds have a total area of 10,000 square feet, or 1 square foot per capita for 10,000 people. The total area is divided into 6 beds by planks set in concrete posts. The sludge beds are constructed of 10

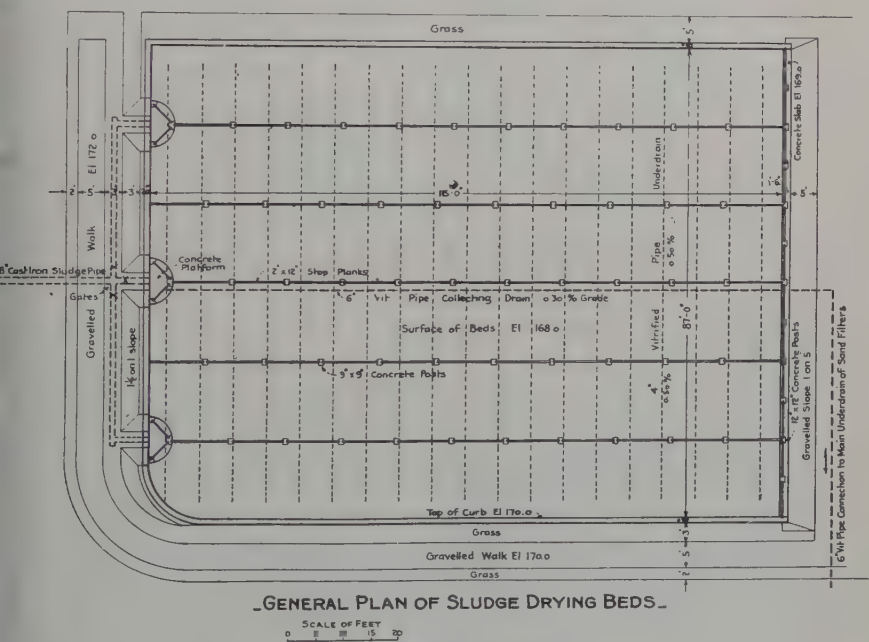


FIG. 10

inches of coarse stone covered by 1 inch of fine stone and 1 inch of sand, and are underdrained by 4-inch pipes laid 6 feet apart, which connect with the main underdrain system of the new filters.

SAND FILTERS AND DOSING APPARATUS

The filters comprise a total sand area of approximately 8 acres, divided into 16 beds. In the center of the field, a concrete dosing tank, holding 1,545 gallons per foot of height and a maximum depth of liquid of 4.6 feet, is placed. The object of this tank is to change the continuous flow from the Imhoff tanks into an intermittent discharge at a rate high enough to insure good distribution over the sand beds. A dosing apparatus, located in the center of the tank, includes a Miller syphon by which, when the sewage rises in the tank to a predetermined height, it is suddenly admitted to a central brass-lined, cast-iron cylinder from which

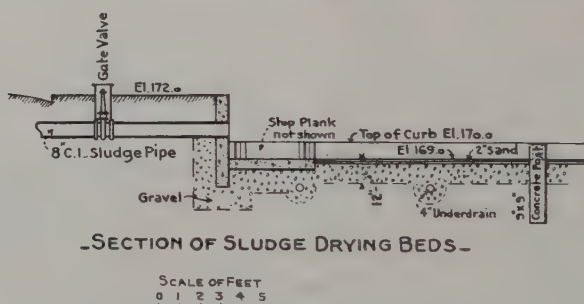


FIG. 11

four openings lead to the four main distributing pipes of the filtration area. Inside this cylinder is another brass cylinder with one opening, which is rotated one-quarter of a revolution each time the dosing tank fills, the opening, therefore, registering in turn with each of the four distributing mains. In this way, with one filter open on each main pipe, four can be automatically dosed in rotation with a definite amount of sewage and at a rate of discharge sufficient to guarantee good distribution. With this intermittency, the evils of a dribbling flow are avoided, and between doses there is opportunity for the air to enter the sands. The size of dose can be varied by changing the height of the auxiliary float-actuated valve which releases the air from the siphon dome. The volume of the dose is equal to that contained in the tank at the beginning of discharge plus the inflow during the period of discharge. Provision is made for by-passing the dosing tank, and should any accident occur to the dosing apparatus, overflows permit the sewage to reach the filters without damage. As in all automatic apparatus, intelligent supervision is necessary to insure continued successful operation.

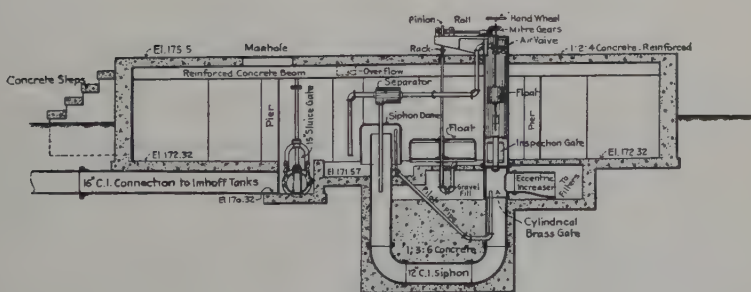
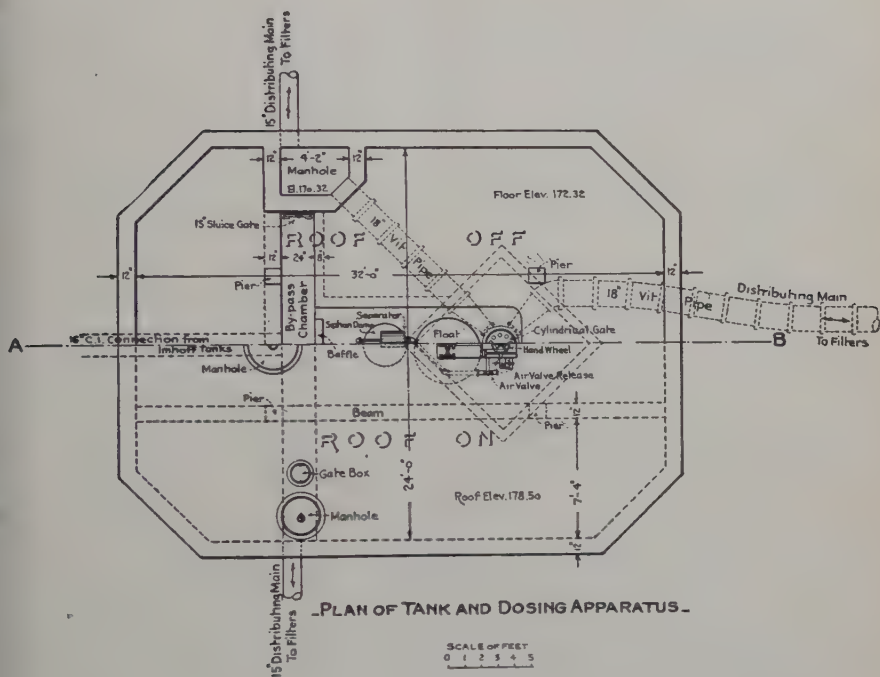


FIG. 12. — PLAN AND SECTION OF TANK AND DOSING APPARATUS

From the dosing apparatus, four lines of main distributing pipes, laid in the embankments, lead to the filters, to which the sewage is applied by operating gates in chambers constructed between adjacent beds. To facilitate distribution on the bed surfaces, wooden "carries," which at intervals reduce in width and slice off sections of the flowing sewage, have been constructed in each bed.

The filters are underdrained at an average depth of 4 feet by pipes laid with open joints and surrounded by screened gravel. This relatively shallow depth, which was made necessary by the character of the deeper soils, requires intermittent application of the sewage in small doses in order to effect good purification, and precludes the practice of flooding the beds as has been followed in the old field.

The filters are composed of sands found in place or transferred from high points to fill in low points. All loam and subsoil were removed, and in general the filter material is clean, sharp sand containing many pebbles and large stones. At certain points, however, the sand is ma-

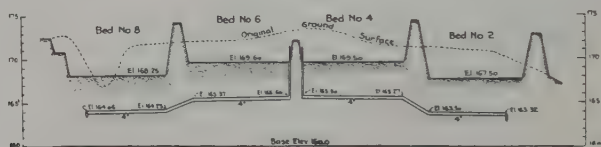


FIG. 13. — TYPICAL CROSS SECTION THROUGH SAND FILTERS

terially finer than the average, and has a tendency to compact, with the result that some beds will successfully handle more sewage than others, thus necessitating an intelligent adaptation of the dose to the character of the material.

In general terms, the new disposal plant consists of two Imhoff tanks which should be capable of handling the sewage from the equivalent of a population of 10,000 people, and 8 acres of filters which, if properly managed, should be able to adequately purify the Imhoff effluent from the same population.

A brief statement of cost of the works recently constructed may be of interest. At Framingham Center the cost of the pump well, superstructure and machinery was \$12,925; the force main, \$17,700. At Saxonville the pump well, superstructure and machinery cost \$12,475, and the force main, \$43,000.

Compared with the works contemplated previous to the report of Messrs. Eddy, Barbour and Larned, which, on the basis of 1923 unit

prices, is estimated to cost \$336,250, and assuming street sewers and additional disposal works as common to both plans, and after making correction for additional cost of the sewers constructed in Warren Road and Prindiville Avenue over necessary street sewers, and including land damage, the saving effected by independent pumping amounts to about \$244,000 in initial construction cost alone.

Some details of cost of additional disposal works are as follows:

Imhoff Tanks (2 units)	\$35,825
Sludge beds	4,000
Sand filters and dosing tank	70,800
Weir chamber, force main connection, connection to old disposal plant, etc.	5,960
Total cost	\$116,585

CO-ORDINATION WITH OLD DISPOSAL PLANT

Provision has been made for by-passing the Imhoff tank effluent to the old disposal area by the construction of a diversion chamber in the 12-inch distributing pipe line leading from the Imhoff tanks to the new sand filter beds. This chamber contains a 24-inch cast-iron weir plate by means of which the sewage passing to the new plant may be measured, and a 12-inch gated connection made from the inflow side of the weir allows a constant head to be maintained on the by-pass line. By throttling the gate, any desired proportion or all of the flow may, therefore, be directed to the old area.

As previously stated, there are three weirs placed at such points that the total flow of sewage reaching the plant and the amount allowed to flow on to the new area may be measured. Provision for the installation of automatic registering devices has been made at these three points by the installation of float pipes and by openings placed in the roof of the chambers.

The necessity for continuous operation of the Imhoff tank to get best operating results was recognized previous to placing the new plant in operation, and as there were no pumping units at the Lokerville station of proper capacity to meet this situation, and the flow from Saxonville was very small and will continue to be so for some time in the future, a small motor-driven, vertical-shaft centrifugal pump was installed at the Lokerville station.

This unit, which includes a 20 h. p., 3-phase, 60-cycle, 220-volt, Wagner motor, a Morris Machine Works single stage, 4-inch pump, —

with Cutler-Hammer automatic starting switch and time limit relay, — was set in the pump well of the old reservoir to which the sewage is carried directly from the screen chamber, and from which any excess inflow over the capacity of the pump overflows the end wells into the adjacent reservoir chambers. The object of this arrangement was to keep the sewage moving to the disposal plant in as fresh a condition as possible, and therefore to store no sewage at Lokerville except the excess over the capacity of the small pumping unit.



FIG. 14. — IMHOFF TANKS

As already stated, the pump was placed in the wet well, not because it would not have been better to place it in an adjacent dry well, as has been done at the Framingham Center and Saxonville plants, but because of the difficulty of excavating a new well in the low ground adjacent to the old station, and because the available appropriation did not make this possible.

The specified capacity of the pump was 450 gallons per minute, but in the test, the unit developed a discharge of 675 gallons per minute. On the suggestion of the Board of Public Works, this discharge was accepted with the understanding that, as the sewage of Saxonville increased to the point which might overload the Imhoff tanks, the discharge of the Lokerville unit would be reduced by cutting down the impeller. At the present time, this pump, if operated twenty-four hours, discharges 972,000 gallons to the Imhoff tanks in that period.

The discharge of this small pumping unit is carried to the disposal field through the old 12-inch force main, part of which had, for some years, not been used. In this way, the sewage going to the Imhoff tanks is kept separate from that sent to the old field by the larger Lokerville pumps through the 18-inch force main.

The installation of the continuously operating pumping unit at Lokerville, by which the sewage without storage in the collecting well is moved at once to the Imhoff tanks, through the settling chamber of



FIG. 15. — SLUDGE BEDS

which it flows in less than three hours, is in line with the controlling idea that in order to reduce odors and to maintain the most efficient sedimentation, the sewage should be delivered to the disposal field in as fresh a condition as possible. The result has been that the odors about the Imhoff tanks and the new fields have been markedly less than in the old field where stale sewage was applied.

OPERATION OF THE NEW PLANT

The operation of the new disposal area was started in July, 1924, under the direction of Mr. Herbert B. Allen, chemist in charge of the Fitchburg sewage disposal plant, who was retained by the Framingham Board of Public Works to supervise the initial operation of the plant.

Owing to difficulties experienced with the Lokerville pumping unit, several interruptions in the operation of the Imhoff tanks occurred.

These interruptions served the very good purpose of proving beyond doubt that continuous flow is necessary to successful operation of Imhoff tanks, because, with each of the shutdowns, gas formed in the settling compartment, heavy scum appeared on the surface, and the tanks lost all appearance of successful operation. The interruption of flow, however, appeared not to have interfered with the digestion process. The



FIG. 16. — PART OF SAND FILTER AREA
Showing dosing tank, carrier and water supply well

first sludge drawn in October, after the plant had been in operation only about three months, was up to the best Imhoff standard, drying quickly, and was easily handled and free from offensive odor.

Available information indicates that an average flow of about 800,000 gallons per day has been pumped to the new disposal plant during the period of operation to date. All of this amount has been treated by the Imhoff tanks. Recent estimates of the connected population indicate that 14,000 people are connected to the sewerage system in the three districts. The total average daily flow for the past seven months is estimated at 1,050,000 gallons per day. On the basis of these figures, the Imhoff tanks are treating the sewage from a connected population of about 10,600 people, or 5,300 persons per unit.

The average daily quantity of Imhoff tank effluent treated by the new sand filters for the past four months, during which period there has been uninterrupted operation, based upon the number of revolutions recorded by the dosing apparatus, is about 543,000 gallons per

day. This amount of sewage has been dosed on four beds, or two acres, daily. Three days' rest being allowed between doses indicates that the area has been operated at the average rate of 66,500 gallons per acre daily, this being equivalent to the sewage flow from 885 persons.

During the first few months the new sand filters were operated at rates as high as 200,000 gallons per acre daily for days at a time. The overloading of the filter capacity due to this operation was evidenced in the staining of the concrete masonry by the iron in the wash water used at the Imhoff tanks, the water supply being from a well excavated in one of the filter beds and fed by sewage filtrate.

After seven months' operation, the surface of the filters is covered by a dark-colored, somewhat granular deposit, slightly crusty. The beds have not been cleaned to date, and were not furrowed last fall for winter operation.

The following table shows data on operation of the old disposal plant since 1915, taken from records of the State Department of Health and available town records, and may be of interest:

YEAR	Area of Filters (Acres)	Sewage Flow, Yearly Average (Gallons Per Day)	Sludge Removal (Cubic Yards)	MAINTENANCE				Population	Estimated Rate of Operation (Gallons per Acre Daily)
				Yearly Cost	Cost per Million Gallons Sewage filtered	Cost per Acre of Sand Filter	Cost per Capita		
1915	20.75	688,000	700	\$6,493	\$25 80	\$313 00	\$0 41	15,860	33,000
1916	21.12	830,000	900	2,802	9 25	133 00	0 17	16,500	39,000
1917	21.12	857,000	1,000	4,118	13 10	195 00	0 24	17,023	40,000
1918	21.12	934,000	1,250	6,818	20 00	323 00	0 40	17,200	44,000
1919	21.12	1,047,000	1,300	5,457	14 30	259 00	0 31	17,400	50,000
1920	21.12	1,263,000	1,340	5,340	11 50	253 00	0 30	17,600	60,000
1921	21.12	1,137,000	1,500	4,689	11 30	222 00	0 26	17,800	54,000
1922	21.12	1,191,000	1,668	4,724	10 90	224 00	0 26	18,000	56,000
1923	21.12	1,293,000	1,281	4,168	8 85	198 00	0 23	18,200	61,000
Average	21.08	1,026,000	1,222	\$4,950	\$13 90	\$236 00	\$0 29	—	48,500

There are no figures available indicating maintenance costs for the new disposal plant, and in any event figures would at this time be of little value in view of the short period of time during which the plant has been operated.

PROBLEMS OF THE CONSTRUCTION INDUSTRY

By BRIGADIER-GENERAL R. C. MARSHALL, JR.*

(Presented April 15, 1925)

MR. PRESIDENT, GENTLEMEN: It gives me great pleasure to come before you again. I had the pleasure of speaking to you some years ago when Professor Spofford was your President and very kindly asked me to come to Boston. At that time I think I expressed to you the faith that I am bound to have in the engineer of Boston, because from Boston, perhaps more than from any other place, came those engineers who did most for the Construction Division of the army during the World War. From Boston, also, came the idea that a cost-plus contract did not necessarily mean cost plus 10 per cent. As a matter of fact, if it did mean cost plus 10 per cent we felt we should not have such a contract.

We had with us during the World War such men as Mr. Main, Mr. Metcalf, Mr. Olmsted, Mr. Rogers, Mr. Tuttle, Colonel Willcutt, Colonel Gow, Mr. Fay, Major French, Major Hamilton, Mr. Barbour, Mr. Eddy, Colonel Gunby, Mr. Fales, Professor Spofford and a great many others I might mention, who were with the Construction Division proper, or were so intimately connected with it as to be a part of it.

Those men who came down from Boston to Washington furnished a great part of the strength of the construction program as it was carried out during the war, and I believe all of those mentioned were members of this Society. So you can well imagine I come before it with the feeling that I know the calibre of the men with whom I am talking, and have every confidence that I can speak with perfect freedom.

I have had assigned to me three subjects which pertain to the economics of construction. It is not my purpose to talk on any technical subject. I am going to speak, rather, upon three matters that affect the business side of construction and affect it very materially. They are matters with which engineers should concern themselves very much more than they do. The engineer is entirely too prone to stick to the technical side, and not to give the business side of construction the attention that it deserves. The consequence is that the business

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side of construction has been neglected. It has had no guidance, as a whole, as to the course that it should take. The "drifting" of such a business must have a tremendous influence on the whole country.

Every one of us, if we are to see our business progress abreast with other businesses of the country, should insist that it be emphasized to such degree that the whole business world shall know what construction means to the body politic. President Coolidge, in a recent address at Washington, said, "Construction of one kind or another largely represents the accumulated wealth of the country."

At the Unemployment Conference called by President Harding, held at Washington in 1921, emphasis was given to the importance of construction as a balance wheel in the industrial scheme. The people who prepare statistics, and there are a number of them around Boston, have since that time looked upon construction and talked about it as the "balance wheel of industry." I believe it to be important that we who comprise the industry should get that thought thoroughly fixed in our minds. If construction be indeed the "balance wheel of industry," then we have an obligation not hitherto recognized by us.

The man in the street thinks construction is "the rottenest industry in the country." He has been permitted to think that partly because it is so and partly because no one has taken the trouble to inform him relative to the true situation. It has not been explained to us, much less to the people at large.

So I propose to try to illustrate at least three ways in which I believe the conduct of construction as a business could be improved.

STANDARD FORMS OF CONTRACTS FOR CONSTRUCTION

Three years ago last December the representatives of eight associations met in Washington to consider the matter of standard forms of contracts for construction. These representatives were from the following bodies: American Association of State Highway Officials, American Institute of Architects, American Society of Civil Engineers, American Water Works Association, Associated General Contractors of America, Western Society of Engineers, American Railway Engineering Association, Federated American Engineering Societies, National Association of Builders Exchanges.

These associations, national in character, — with perhaps the exception of the Western Society which is almost national in its scope, — had sent representatives to the conference for the purpose of formu-

lating contract forms that might be used in all fields of construction work. It was felt that the business relations in construction should be the same wherever in this country construction is carried on and whatever its nature; that the interpretation of plans and specifications, who should interpret them and how, in so far as it affected the cost and time of operation, the method of making payments and when they should be made, the method and time of determining costs, and other matters that were purely business as differentiated from the technical, should be the same wherever and whatever the nature of the construction work. That was the fundamental purpose of that conference.

In other words, it was felt that the business of construction was susceptible to definition, so that whenever business relationships were entered into they might through usage become exact and hence the gamble in the industry be eliminated. There is no reason why, so far as the business relationships are concerned, all contracts should not be drawn up upon the same basis. Of course in certain respects all contracts and specifications have to be special. Only certain clauses can be standardized. After discussion the representatives at the conference concluded that business relationships should be identical. But then came the practical consideration as to whether the contractors were ready to put such a contract into actual practice. The conclusion was that it could not be done quickly, but that it ought to be done and that it should be. Therefore, as a first step towards bringing this situation into accord, they started to prepare two standard contract forms, one for building construction, and the other for engineering construction.

I expect that most of you gentlemen here know of Onward Bates who was the chairman of that conference. The high regard and respect that we had for him had much to do with the formulation of the fundamentals upon which the conference proceeded.

It has taken three years and a half for that conference to come to a conclusion, and when I use the word "conclusion" I am using the wrong word, because the matter is not nearly concluded as yet. The principal stumbling block encountered by the conference was the attitude of mind of the engineers. It was to them that the idea of arbitration had to be sold.

Any inference that the engineer may not be honest immediately makes him very rigid. He doesn't break because there isn't force enough on the other side to break him, but he doesn't bend because he is too rigid.

The matter of arbitration doesn't in any sense involve the question

of honesty; but the engineer cannot seem to comprehend this. He thinks if one talks of arbitration his integrity is being questioned. There is no man, engineer or whatever he may be, who will willingly put his business life arbitrarily into the hands of another man however honest he considers him. Yet construction contracts, particularly those with governmental agencies, all too frequently do that very thing. The business life of the man who gets that contract is in the hands of the person in charge, whether that person be an engineer or an official.

This conference finally agreed, with respect to arbitration, that whenever a question came up during the progress of the work, where the interpretation of plans and specifications involved cost, then that question could be submitted to arbitration; and similarly, whenever a question came up regarding the interpretation of plans and specifications as affected by the element of time, then that question, too, could be arbitrated.

The power of the engineer to absolutely dictate the conduct of the work is not a subject for arbitration, but where that dictation takes the form of increased cost or increased time, then these matters are subject to arbitration.

Several states have adopted arbitration in their highway contracts. Georgia, Iowa and Minnesota have now provisions for arbitration in highway work. In all those states the chief engineers report, after one or two years' experience, that the arbitration clause has worked out so satisfactorily, that now they have become advocates of it. As a matter of fact, in most of the states arbitration does not keep one out of the courts. In other words, it is not binding. The Arbitration Association of America, however, is now working in a great many states to provide statutes that will make it binding when in a contract. Three states have passed such legislation, — New York, New Jersey and Oregon. Until such statutes are passed, the right to go to law is not denied, although, of course, the use of arbitration acts as a very strong element in a court of law.

The first meeting of the conference was opened by Secretary Hoover with a well-considered statement, for he has taken a great deal of interest in the standard form of contract. It was difficult for these nine different representatives to first enunciate the different principles that should go into the contract. But it was even more difficult to express those principles in the proper words.

In January, at the conference of the Associated General Contractors, which was addressed by President Coolidge, Secretary Hoover, Post-

master General New, Secretary Work, General Lord, and Senator Wadsworth, every one of those men had something to say about the necessity of a standard form of contract, and deplored its lack. When men as prominent in the affairs of the country as these note a condition, one knows there is something the matter. I want to read to you what Secretary Hoover said as to the effect that the standard form of contract would tend to have:

I know of nothing that will tend more to create stability in the contracting world, will give better protection to both the contractor and to the public, than a more uniform contract, based on a more careful and scientific understanding of both the material and the economic and the legal problems that are involved. There are great economies for the consumer; there is more stability for the contractor; and in one, perhaps a side issue to such an effective basis of relations, there are great economies for the Nation, and that is in the reduction of the amount of misunderstanding and conflict and fraud and litigation that grows out of badly expressed and badly entered upon contracts. You have been insistent, in the interest, not alone of yourselves, but of the people whom you serve, and fundamentally, rightfully so, in the introduction of arbitration clauses into contracts. And it goes further than merely your relations; it goes to the elimination of a national waste, for the Nation has to support all of the machinery by which conflict is fought out.

The building contract form and the engineering contract form have now been completed and will soon be ready for general distribution. The building contract form will be issued as the Fourth Edition of the Contract of the American Institute of Architects, and the engineering contract as a conference form. We hope that these forms will gradually be adopted for all commercial construction and eventually for government construction in the states and municipalities. Some states are already using them, notably Iowa, where the association of municipal engineers has interested itself in the standard form.

USE OF DAY LABOR BY THE GOVERNMENT IN CONSTRUCTION WORK

In the last three years we have been making a study of government in business as it pertains to the construction industry. The United States government in many of its departments does much of its construction work by force account or by "day labor," as we call it. Various states also are doing much of their construction work by the day-labor method rather than by contract. Many municipalities do all of their street work and most of their water and sewer work by day labor as opposed to the contract method, and so on down the line. Some of it is justifiable. We all know that there are occasions when it is distinctly

to the interest of the people that governmental work be done by the day-labor method. On the other hand, we all know that fundamentally, on principle, where the government does work that can be done commercially, it is contrary to the basis on which our prosperity has grown, and that it ought not to be allowed.

We can assert with confidence that there is done by day labor in this country more than five hundred million dollars worth of work yearly that should be done by contract. That being the case, it is of interest to all — whether that work be done in California, Florida or Massachusetts — to know about it and to come to a distinct conclusion as to what should be done. It affects the country of which you are an integral part, and the transmission of your thought will in turn have its effect.

In the Republican platform appears this:

The prosperity of the American nation rests on the vigor of private initiative which has bred a spirit of independence and self-reliance. The Republican party stands now as always, against all attempts to put the government into business. American industry should not be compelled to struggle against government competition.

President Coolidge in his speech of acceptance, said in part, "I favor the American system of individual enterprise and I am opposed to any general extension of government ownership and control."

The Democratic platform had a similar provision, and John W. Davis in his speech of acceptance made a statement entirely parallel to that of President Coolidge.

So, whenever our leaders of governmental affairs have assembled for the enunciation of the fundamental laws of our country, they have said in no uncertain terms that the government should not go into business; that business is a matter of private initiative; and that if the country would foster prosperity, anything the government does to destroy private initiative is a step backward.

Whenever any governmental agency does construction work, or other work, by the day-labor method it has violated one of our fundamental principles. When we violate a principle we do some harm. This violation may not become apparent through outward result, but with repetition it will eventually react upon ourselves — too often the harm becomes grafted into us and eventually it breaks us down as far as that particular hurt can break us down.

I should like to mention a few instances of work done by day labor and of opinions with respect to it. The Gila Dam in Arizona was

estimated to cost \$800,000. It was built by day labor without change of plan, and it cost nearly \$2,000,000.

Two years ago in Detroit the city built a garage. The cost was estimated at \$550,000. The mayor was importuned not to do that work by day labor, but he determined to go ahead with it. After it had been completed injunction proceedings were brought by some citizens of Detroit to prevent the city from using the garage. The question of its construction came up in court, and their sustaining costs showed an amount above the estimate. The difficulty in all such cases has been in actually ascertaining the total cost.

The Governor of Michigan, so I am told, thought the mayor was doing good work politically, — that his political pay roll was increasing, — so he determined that state work should be done by the day-labor method. Consequently he started doing some highway work by day labor, and gradually increased it until now all of the state highway work is done by that method.

Two years ago there were 100 highway contractors in Michigan; today there are less than six, and these do some work in other states and some other classes of work. Naturally, so far as that class of work was concerned, they were wiped out of existence. The result has been total elimination of an industry.

Development of day-labor work by any governmental department ultimately makes for one of three or four dire effects. In Michigan the eliminating of an industry has not only wiped this out but others also. In this highway work costs had been compiled on 8 miles of 18-foot concrete pavement. This cost \$50,000 a mile, whereas the average cost would have been, I think, \$32,000; which means that they have obtained 8 miles of road and have paid for 14 miles. It means, further, that the cement industry instead of having sold cement for 14 miles of road has sold only enough for 8 miles. And the same thing applies to sand and gravel. It also means that no more people have been employed during that time than would otherwise have been employed.

Similarly, in other respects the state has gone into business. It has bought a cement mill. There were three twine manufacturers in the State of Michigan, but today there are none, the state having gone also into that business.

Now I should like to comment on the effect this procedure has upon the mental attitude of the people. I think I can express it best by what the Michigan committee has in mind relative to business.

They have in mind a recommendation that all business men of the

State of Michigan refuse to pay any state taxes, for the reason that the taxes are taken by the government of the State of Michigan to run its business. "Why pay taxes to set up a competitor?" is the logical question. The effect is that the "day laborites" are against the government. They are Bolshevistic. This situation has set up a state of mind that will eventually lead to undermining governmental authority if it goes much farther.

Not only the States have this tendency, but the Nation. The Mississippi levees are under the charge of the Mississippi River Commission, divided into three levee districts responsible for the construction work. In 1918 one of the districts (the Third District, I think) bought its first levee machine. Ninety-three per cent of the work was done by contract. In 1923, 85 per cent of the construction work was by day-labor methods; but how was that work done? I personally investigated the report of the chief of engineers who transmitted the report of the Levee Commission. The investigation showed that the specifications were violated in every essential, and that the work cost 30 per cent more than it would have cost by contract. I will give a few examples of what had been done. Examinations were made of three 50-foot lengths of levee. The amount of foreign matter in the shape of logs and timbers found in this portion ran $5\frac{1}{2}$ cords to each 50-foot length. Those of you who have given any attention to levee work know how necessary it is that no foreign matter be permitted in the bank. I might say, also, that the borrow pit was brought right up to the toe of the bank, which is exceedingly bad practice. This made the levee unsafe. There was no protection to the people behind it. There is no protection to them, and they will be forever in constant danger from those levees.

There is no question about the violation of those specifications, because the investigation of conditions was made by engineers belonging to the Mississippi River Commission and not by outside parties. It was their own report.

All this draws attention to the fact that not only does day labor work do harm to industry, but it is usually accompanied by wholly unwarranted violation of the specifications, with deviation from what the job was originally conceived to be.

Under the Department of the Interior, the last \$120,000,000 worth of work was done by the day-labor method. An engineer in one of the western states took the trouble to investigate those projects and found that the original estimate on them was \$62,000,000. Now just con-

ceive that you are farmers and are taking a section of land at \$100 an acre, to be improved for agricultural purposes, and find that the improvements cost \$200 an acre. Would you be against the government or with it? What is the effect on the citizens of the country? Is it our duty to think of it from that point of view or from the point of view of dollars and cents?

I will quote from a speech made by Secretary Work:

It has been frequently stated that the government only gets 60 cents for every dollar it spends for public improvements. The reason given for this is that employees will not work as diligently for a municipality, a county, a state, or the national government, as for private employees under the eye of the master.

Recognizing as I did that his department was filled with people whose employment depended on a continuation of the day-labor policy, I felt sure that he would have a hard time getting by with his announced policy; and he did. The first four jobs which came in after that were recommended against by the field engineers, who urged that the work be proceeded with by day labor, and they gave estimates of the field engineers and quite cogent reasons why such a conclusion would be to the interests of the government. For example, there was question of relining a siphon in Idaho in the winter time when it was not in use. It was a 6-foot siphon 4,500 feet long, to be reinforced with chicken wire. The bid price was \$45,000. The estimated cost of the engineer in the field was \$22,000 — quite a wide margin of difference. But the engineer, after exhaustive correspondence, still maintained that he could reline that siphon for \$22,000. It was absurd, of course. It was difficult to take such estimates up with the Secretary of the Interior and his assistants and convince them that the figures given by their field engineer, and not condemned by engineers in their own office, were unjust.

Another project was that of a dam which cost one and a half million dollars. And there were two other projects. The estimates on every one were absurd, — as much so as the relining of the siphon. The question of how to convince the Department resulted in one amusing incident. I was trying my best to get something to illustrate the thing in such a way that the man working in the street could see it. Finally I found that the labor cost for lining that 4-inch concrete facing of the siphon in Idaho was the same as the labor cost for laying a 4-inch concrete sidewalk in Washington in the summer time. That was manifestly absurd when one considered the forms to be put in and the "slop" to

go into that siphon. The whole proposition turned on that one little thing. But that showed conclusively that the figures we were suggesting were safe, and that the estimates coming from the field must be based on something other than the written plans and specifications. With that as a starting point we were able to help Secretary Work to decide that the relining of the siphon should be deferred until the next winter, and that it would be better to let the other three jobs by contract.

Secretary Hoover said in his speech at the Sixth Annual Meeting of the Associated General Contractors of America:

I would like to see an independent investigation in the relative cost of construction of public work departmentally as opposed to contract. I believe that there would be here demonstrated a great public waste. It is my belief, as an engineer, that construction by contract of public work makes for national economy.

The situation is growing worse almost day by day, and in my judgment it is a part of the duty of the engineers of the country, who ought to be the leaders of the construction industry, to take conscious thought of this and not to let it drift.

It is a serious thing, not only to your business but to your country. It can make Bolshevists.

If you do not look after the business that you are in, who is going to look after it? If you do not protect it from inroads, — as far as the government is concerned, — who *is* going to look after it? It is not being looked after now. It is being permitted to drift. I think my statements are sufficient to show by their diversity that the situation does not apply to any one section in particular, but to the whole country, and I hope I can leave with you a sufficient comprehension of its seriousness to make it a part of your conscious thought.

THE IRRESPONSIBLE CONTRACTOR

The third subject I am to discuss is that of the irresponsible contractor. The contractor has been, of course, the element that produces, in large measure, the bad reputation of the construction industry. Indeed, he probably has been the principal source of it. The question of how a contractor is begotten is one to which the engineer is entitled to give serious consideration. Our children may be bad, but we still must feel some responsibility for them. I question whether the engineer would call the contractor his child, and also whether the contractor would not resent the assumed relationship. At the same time, the

irresponsible contractor is the element in industry that gives to it its gambling reputation more than anything else. Anybody can be a contractor, whether he has ever seen anything built or not, and a great many who have never seen anything built do become contractors. There should be some method of obviating this. There should be some apprenticeship system of bringing the contractor into being.

In June of last year there was held a meeting in Washington by representatives of the American Association of State Highway Officials, the Surety Association of America and the Associated General Contractors of America. At that meeting the responsibility for the irresponsible contractor was laid squarely at the doors of the surety companies. It was done not by the general contractors, — although they were perfectly willing to do it, — but by the representatives of the State Highway Officials. At that meeting there were, I think, eight of the highway officials who spoke. Each in turn gave illustrations and told the representatives of the bonding companies who were present just how and why they were responsible for the irresponsible contractors in their state. The surety representatives came to that meeting with every conviction that the surety business was conducted under rules that would produce perfect underwriting. They brought with them the forms that they used in their home offices, and asserted that these forms had to be fully filled in before the bond was ever authorized from the home office. They assumed that after the form had been filled in as required then the underwriting was fully justified. That state of mind seemed unanimous on the part of the surety companies. One of those very companies had, however, the year before experienced 1,790 failures. It was fortunate that the State Highway Officials were there and were willing to make out so perfect a case. Otherwise the realization would never have been brought home so well to the surety companies. When the highway engineers got through the surety officials freely agreed reform was imperative. They do not acknowledge that their responsibility goes as far as those not in the business see fit to charge, yet they do acknowledge that they have a great responsibility with respect to who shall be bonded and who not bonded. It was stated repeatedly at the meeting that "anybody could get a bond." There were three committees appointed at this meeting, and I want to read a short extract from the report of Committee No. 1 at a subsequent meeting of the conference. This committee had a representative of a surety company as its chairman, and a representative of a surety company wrote the report.

This committee desires further to emphasize the fact that at present conditions are not satisfactory. Practically any other contractor, whatever his financial standing, whatever his experience or lack of experience, whatever his equipment, sufficient or insufficient, whatever the relation of his liquid assets to the amount of work he has on hand, whatever the extent to which he has become overextended, can obtain a bond. Some surety company will execute a bond for him, and he goes from one company to another till he gets what he wants. The irresponsible contractor can usually find some company to go surety for him. This is the result of competition. As bearing on the conditions, it should be noted that it is the almost invariable practice for the owner to award the contract to the lowest bidder. The consequence is that the surety company must execute the bond for the bidder who presents the greatest hazard in the group of bidders. The surety company gets the worst risk in the lot. The selection is against it.

I do not believe that one of you gentlemen sitting in this audience could write as severe a condemnation of bonding practice as that. In governmental circles where the law requires that the lowest responsible bidder shall be given the work, it is difficult for work to be denied to any one who can get a bond. It is not always impossible, but it is extremely difficult. The measure of responsibility is almost universally the ability to get a bond, and if a bid is made upon public work and a bonding company will notify an awarding official that they are good bond, it is almost a matter of course that that award will be made. From that point of view it is incumbent upon the surety companies to protect the public and protect the industry, and from that point of view they are responsible for the irresponsible contractors.

I again want to draw attention to the fact that I am talking on specific subjects, and in condemning those specific subjects I am not necessarily picking cases. In other words, I am trying to analyze what is a fault, and am trying to state it so that you shall comprehend it. When I condemn bonding people for their practice I am not trying to cry them down in order to cry the contractors up. That mistake is often made, so I want to be perfectly clear about it. I might point out as many faults in the contractors as I am finding in the bonding companies, but I am not here for that purpose.

Here is one practice of the bonding companies that I want to say is not common, but which happens often enough to make it highly objectionable and which I consequently desire to condemn. The following letter was written by the representative of a surety company to a contractor:

We have been informed that you are to submit a bid on theat.....
It so happens that our agent, Mr. —, is president of the commission in charge of the

work, and it is at his request that we are soliciting the contract and labor bond required, as well as the compensation insurance covering this job.

As you know, the is one of the biggest in the business. Also, we are the only company in this vicinity maintaining a large claim department. Furthermore, we have the necessary bond forms which will enable us to deliver the bonds within the specified ten-day limit.

As you doubtless can realize, Mr. — is an important factor in not only obtaining this job but in successfully performing it. We wish you would advise us immediately in regard to your position in placing the bonds and insurance if you are the successful bidder. If you feel that it is to your advantage to promise us this business, we will then forward the necessary blanks and make further arrangements.

Please let us hear from you by return mail.

That is not common practice of the bonding companies, but things like that do creep in often enough. The agents of bonding companies are so interspersed throughout the life of construction work that scarcely anywhere do they fail to influence the award to some extent, — cashiers of banks, tellers of banks, some of the clerks, and so on down the line. It is a practice that the bonding companies, in their own interests, recognize that they must stop.

The high officials of the bonding companies were almost oblivious to the fact that this sort of thing was going on, and we did not talk to them nor am I talking to you, in a spirit of belittling them. But I am talking to you from the point of view of helpfulness. All of you gentlemen are in a position where you can help the bonding companies in some material way in respect to this. If the attention of any home office is called to wrong methods, that home office will do its best to correct them. The home offices of the bonding companies are absolutely desirous of the proper ethical working of their business. As I said before, they came to that meeting a year ago oblivious of the situation as it existed. They were the most surprised men in the room when they heard what the State Highway Officials had to say, and those who were there were fully convinced that they should proceed along the line suggested at that meeting. Unfortunately the Surety Association of America has not seen fit to go as far as that conference recommended, and apparently they will not put the exertion into it that it was hoped they would.

The principal thing that we enunciated at that conference — and I think it was unanimous — was that the difficulty of the bonding business arises from this, that the livelihood of the man who reports on a contractor depends upon the commission he receives, if that report is accepted. In other words, the livelihood of the agent who investigates

a contractor depends upon his report being favorable. That is an inescapable fact. That is the way they conduct the business. Suppose I have the offer of a million dollar job when I am not good for that job at all, and the surety company's agent will receive \$2,500 as his commission if he makes a favorable report. That situation must be changed if the difficulties of the business are to be remedied. It is throwing too much of a burden on human nature. It might well be expected that just what has happened would happen.

The Surety Association of America at its meeting in December did not take the steps many thought it ought to take. The consequence was when the American Society of Civil Engineers had a meeting in January the Highway Division in particular took the matter up and proceeded to give some little consideration to it, I am informed. I was in attendance at another meeting so I did not hear that particular discussion. As a result the conference was called in Washington, not only of the Highway Officials and the Associated General Contractors, but other elements as well, with a view to those elements expressing what they thought and then having a meeting with the Surety Association. At that meeting there were present representatives of the American Institute of Consulting Engineers, the American Association of State Highway Officials, the Associated General Contractors of America, the American Society of Civil Engineers, the American Institute of Architects, the American Society of Mechanical Engineers, the American Society for Municipal Improvements, the Highway Industries Exhibitors Association (manufacturers of construction equipment and material) and government officials.

Personally I believe the corporate surety bond is the best form of guaranty that can be had. I think it is to the interests of all that it should exist and that we should each do our share to help further it. But the situation is so acute in many states that the State Highway Officials and other officials are considering whether it would not be best for the state to do its own bonding. The government officials in Washington, representatives of the Federal bureaus, are considering the same thing, and considering it seriously. As I said before, I think it is a very serious mistake, and I think it would lead to worse evils than now exist. If we can all come to a full realization of this bonding situation and give that our conscientious thought, we can do something to help alleviate it and perhaps prevent the government from again going into business.

Gentlemen, I can only reiterate that these three matters are of

serious import in your business, and although they may not appear to affect you directly, they are bound in course of time to do so, and they should be put on a proper plane. Therefore I submit them to you and ask for your helpful consideration in connection with them.

Discussion

LEONARD C. WASON*

I have been associated with General Marshall in some of the above activities. I would like to call attention to a few things which through haste he did not mention.

First in regard to the contract situation. Many years ago the National Association of Master Builders tried to formulate a contract in co-operation with the American Institute of Architects. The first edition of the contract of the American Institute of Architects was better than any previous form, probably, but it was far from perfect, and the Associated General Contractors felt there was need for improvement, so they started working on it about three and a half years ago. Originally the Master Builders, who were the petitioners, were not met by the Architects on an equal basis. The desire of the Associated General Contractors was to bring all interested organizations together on an equal basis. I think I am stating it correctly when I say that it was through General Marshall's influence that Secretary Hoover was persuaded to call a conference of nine National Societies so that they came together and met on a common ground of equality.

He omitted to state that the Bureau of the Budget has struggled with the problem of a uniform contract, and has adopted one based largely on this conference report, for use by the Federal government, including an arbitration clause.

It is my conviction that the method of making the award is just as important as the standard contract itself. Unless there is a fair method of award the result is far from satisfactory. Unless the award is fair, one side or the other will be always struggling for improvement. The following may not be the ideal way of solving the problem of awarding contracts, but one of the steps toward it would be to eliminate the undesirable contractor by the use of a questionnaire; require all prospective bidders to answer questions which will give any engineer a clear insight as to their competency to undertake the work; make sure that

* President, Aberthaw Company, Boston, Mass.

they are competent in advance of permitting them to make a bid, and eliminate the irresponsible contractors. In other words, require the engineer to do in advance what he sometimes does at the end, namely, determine the merits of the various bidders, then select the lowest best bidder.

When such a man as the chief engineer of the Board of Water Supply of New York will not award a contract for a big dam to the lowest bidder when the second bidder made a price of \$2,000,000 higher, you can see what serious responsibility the situation demands of an engineer. I presume the conditions justified the award. The usual practice is to follow the line of least resistance, namely, to select the lowest bidder provided he succeeds in getting his bond. But you do not obtain the best work that way. That is an important element we have to consider. We ought, by the questionnaire, to eliminate the irresponsible contractor, select bidders all of sufficient ability, and then let the contract to the lowest, and you will save money, time and trouble.

In regard to day-labor construction by public officials, at present the State of Michigan does all its work in this way. A citizen's committee in Michigan made a statement that they had found that the cost of doing work by day labor was 40 per cent more than by contract. If this is so, then there is an avoidable loss to the taxpayers with the vast amount of work which is done that way annually by the Federal government, — viz., \$500,000,000. I understand that the states, counties and municipalities do as much more. By applying the above percentage to all work done by day labor the taxpayers are being stuck \$400,000,000 excess for \$600,000,000 worth of work if done by contract. You are all taxpayers. Everybody is interested in eliminating this waste, so we ought all to take a keen interest in trying to do our best toward eliminating it.

An important point in regard to controlling day-labor contracts under the government is by inspection and accounting. We do not want to absolutely eliminate day labor. It ought not to be eliminated by law, because, as the previous speaker said, it is sometimes justified. I think we should control it and that the surest way to do this is to apply to government the methods we use in private work. If a designer on private work lets a contract by competitive bidding to a contractor, he puts inspectors on to see that his plans and specifications are lived up to. These are complete at the beginning, so the contractors know what they have got to do. On government work we ought to follow the same practice.

General Marshall has told us how the government specifications were ignored on levee work, where logs and trees were allowed in embankments that it was absolutely imperative should be solid fill free from foreign matter. This was done to save money. My suggested remedy is to apply the principles of private work to public work; that wherever any government official decides to do work by day labor some higher and independent authority shall put inspectors on the work and see that the plans and specifications which must be complete before starting work are lived up to. I believe there should be a competent construction engineer acting as inspector with as much authority as is customary on private work, who should report direct to a higher official than the day work operating officer, and that there should also be a competent auditor on the work to see that every expense relating to the work is accounted for. To illustrate, sometimes another department has a quantity of idle equipment which they loan, and its operating and depreciation cost does not go in, but as it is actually used it must be allowed for and its cost be accounted.

When these two important items of control are installed, and the reports on such work are made public or are always open to inspection to any interested party, the various departments contemplating day work are going to think twice before they subject themselves to the scrutiny and criticism of doing poor work expensively, whereas they now escape because there is no method of checking them up.

With regard to the too great ease of undeserving persons obtaining bonds, I can recall the statement of one of our associated contractors at one of our meetings in Chicago a few years ago. He stated that 8 miles of concrete road was let in Michigan to a barber and a dentist who had never executed a contract in their lives, but who could get a bond. Now you cannot obtain good work out of an inexperienced person, even though he is willing to do right. Not one of us would think of going into court and attempting to plead our own case. If we did we should expect to lose it, and it is more so with contracting. Highway building is a technical operation especially in large units, requiring special training, years of experience and expensive plant, and you cannot expect to obtain good results under any other circumstances.

Now bonding companies are responsible for producing just such contractors as that barber and dentist, and just such bad work, also, for burdening the taxpayer by their unbusinesslike methods.

In one of the recent issues of the "Constructor" an analysis was made of the merits of the defaulted highway contracts in the State of

North Carolina during the past year. There were 29 contracts considered, and out of them only two were found to be by worthy contractors — men who knew how and tried to do right. Some of the others were notorious crooks who had served time; some were well known to the bonding companies, having been bonded before but failed because of crooked methods; some were totally ignorant of construction methods; some had inadequate capital; and some inadequate plant, or none.

This means taking the work out of the hands of the responsible contractor, and when they do obtain work they are loaded with a double burden. The surety companies have been trying to meet the situation by raising the rate. It used to be half of 1 per cent or \$5 a thousand. For instance, with a hundred thousand dollar contract the bond was for one-fifth of this amount, and we had to pay \$100 for the bond. To-day they charge a flat rate of $1\frac{1}{2}$ per cent on the face of the contract, which means \$1,500 instead of \$100, — an increase of fifteen times. And they are talking of raising the rate more, which will only make matters worse instead of improving them.

Looking back to the time when the railroads were competing with one another, the methods they used were extremely unfair and were injurious to themselves and to the public. Then a higher body stepped in and straightened the situation out. It was very common in this state, for instance, to issue passes to anybody thought to be helpful to the railroads. When by law the railroads were forbidden to issue passes so generally, they objected, but they soon learned that this action added to their revenue very handsomely and did not hurt their standing in the community. Now it seems to me that it would not be a bad thing if some high authority should step into the bonding situation and straighten it out. If the agent of the bonding company, who frequently passes on the risk he writes, should have to lose his brokerage if the contractor prove irresponsible, or if his commission should be made payable only upon condition that the contractor does not default, this would make him more careful. Or an investigating bureau might be instituted, of men on a salary, who have no interest in the premium on the bond, and who will determine jointly for all bonding companies the standing and ability of the various contractors who wish to obtain bonds. If this is not sufficient, apply the questionnaire principle to the bonding companies themselves.

If any of you gentlemen went to a bank to borrow money the banker would consider two points, — the moral risk and your ability to repay

the loan. The state insurance departments have only considered one of those two points of bonding companies, — their financial standing. If we determine the moral risk of each bonding company, or its attitude toward honorable business methods, and if the surety companies who do not measure up to the standards set by the state had to forfeit their license to write bonds, I think the conditions would surely improve. A few of the bonding companies want to underwrite in a businesslike way, but the jealousies of a few others and the smug contentment of one company in particular which is making a success out of a rotten situation has been a stumbling block not permitting a solution as yet.

I wish to impress on the minds of you gentlemen the fact that due to the very rapid growth during the last sixty years, industry and basic inventions have overturned, yes nearly revolutionized, our former established social customs. These enforced rapid changes have outrun our understanding and analysis of the economic principles upon which they are founded. In our confused groping for a firm foundation, many elements of society have gone astray and committed grievous mistakes which we must not repeat. In moving out of the period of individualistic effort to that of co-operative effort it is extremely difficult to get the individualistic man to take orders. This man has been in the habit of giving orders, and it is extremely hard for him to submerge his own ideas when at variance with the majority, and to take orders from his trade organization for the general good. But I believe that the greatest good to the greatest number comes from methods which are honorable and just to all and which give no favors to any, and this is the way in which we are trying to solve our problem — not by the “strong arm” or big stick, but by education and co-operation.

WILLIAM F. WILLIAMS*

I have been very much interested in General Marshall's discussion this evening, as he has raised many questions of interest to engineers and also to contractors — although I do not see many contractors here.

We must not forget that this subject involves a very large measure of what we sometimes refer to as “the human equation,” and if we assume that any part of the problem is wrong we very easily arrive at the conclusion that any change will make it right. I do not think, however, that you can come to such a sweeping conclusion.

Engineers have been striving for a standard form of contract for

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many years. It has been a troublesome question because an ideal combination of law and engineering is difficult to bring about. The contract forms used by the Commonwealth of Massachusetts have received careful study for many years, both by the engineers and by the legal department of the state, and it is my conclusion that one cannot make alterations in either the law or the engineering without careful study. I think that as far as the interests of the Commonwealth are concerned the form of contracts used in the Division of Highways and the Division of Waterways and Public Lands may be considered as perfectly safe. Perhaps they are too severe in certain details.

When the standard form of contract is published I shall be very glad to compare it with our state form, but contractors must not think that a state contract can be so drawn that it will insure them a safe road to success. Every contract must be interpreted with some degree of intelligence and with a reasonable consideration for the facts.

Engineers should realize that they are engaged in a co-operative work in which they must try to work with the contractor. The contractor must do good work if he expects to stay in the business, and the engineer must, of course, protect his reputation by securing good work. There will be conflicts of opinion between the engineer and the contractor, and possibly the contractor may suffer in order that the engineer may escape responsibility. These situations are very unfortunate and we should all strive to prevent them.

I am not a very strong believer in referring contractors' claims to arbitration under state contracts. It sounds eminently fair, but from what I have seen of it in actual use I should prefer the courts. As a matter of fact, very few situations arise under a contract honestly administered by both sides that cannot be amicably adjusted if the questions in dispute lie within the power of the engineer to settle. If recourse must be had to the courts it is the usual practice in this state to submit the claims to a master who virtually becomes an arbitrator, and his findings upon the facts can be made binding on both parties by agreement. There may be cases, however, where neither side would care to take the responsibility of such an agreement, or where the law might not permit it.

The contracts of the Commonwealth are so rigid that no engineer representing the state, or even the Commissioners, have authority to alter their terms, especially if they have been approved by the Governor and Council.

Sometimes situations adverse to the contractors are created by

rather enlarged views on the part of the engineers as to their authority. This is a very unfortunate mistake because both parties to a contract are equally bound by its terms. Engineers do not always grasp the fact that they are equally bound with the contractor, but they should never make changes without careful consideration of their authority under the terms of the contract.

I might take either side of the question of day labor *versus* contract labor, as there are arguments favorable to both sides. In the Michigan case cited by General Marshall, where the cost was so much in excess of the engineer's estimate, it would be interesting to analyze the original estimate of the engineer. I am sorry to say engineers' estimates are not by any means sanctified and are not always correct. But as a matter of practice, good work can be secured by either method. It all depends upon the conditions, and, in particular, the human element. If you are carrying on work by day labor with honest men under efficient and intelligent supervision you will get good work at the lowest possible price, because there will be no profit in it. If, on the other hand, you are working with political appointees who know little about construction and care less, the work will cost a great deal more than it ought to. But you can have the same difficulty with work done by contractors, and I think we might recall a great many cases where the costs of contracts have grown far beyond the original estimate of the engineers. On the other hand, there are a great many cases where the final cost has been kept well within the engineer's original estimate. It all comes back to the individual — to the question of his honesty, his intelligence, and experience. Therefore you can get good work by either method at a reasonable cost.

As to how the question of method may affect business is another matter, and I quite agree with the General that no government, state or municipality should go into any work that can be furnished by a private corporation or individual. This country has been developed through the opportunity it has given to individual effort, and I do not want to see our people deprived of that encouragement simply because we have become a great Nation. This country must continue to grow, and its people must be able to stand on their own feet and not be beholden to patronage or any paternalistic device that stifles individuality or initiative.

There used to be considerable controversy as to the right way of taking care of a macadam road, and as a matter of practice it resulted in letting the road wear out and then rebuilding it. Now the Division

of Highways has adopted a plan for our state roads of constant maintenance in so far as our climate will permit.

The state's large mileage of water-bound macadam roads (some call them bituminous macadam because they are black from frequent oiling) would soon be impassable if they were not constantly under maintenance. This work is done by day labor, although a good deal of thought has been given to placing it under contract. It all depends upon the efficiency of the employees of the Department. It is a very simple matter to prepare plans and specifications and let a contract for building a road of whatever type you select, but it is quite a difficult matter to draft a contract for the maintenance of a number of miles of road, so as to secure efficient results at a fair compensation to the contractor. Until we are able to work out a practicable solution of this problem, the Department will be obliged to continue road maintenance with its own force. It is very costly because of the large mileage of gravel and water-bound macadam roads.

With the present intense competition between contractors for state highway contracts and the high quality of the work performed, there is no incentive for the state to build roads by day labor; but this conclusion has no relation to the variations in cost of work compared with original estimates.

The cost of surety bonds on highway contracts with the state are too high for the risks actually assumed by the surety companies. The history of the state's highway contracts in the past twenty-five years shows very few losses by the surety, but a very large collection of premiums.

The surety companies in their defence say that the high premium is due to the lien law of Massachusetts, which permits the filing of claims for materials and labor furnished for a period of sixty days after the work is completed. On the other hand, they say nothing as to the protection furnished them by the provision in the state contracts for retaining moneys due the contractor to pay claims filed at any time during the progress of the work. Nor do they make allowance for the retention by the state of 15 per cent of the value of the work done until sixty days after the completion of all the work.

Their answer to these claims for special consideration is that rates cannot be made for Massachusetts alone, but must take into account conditions in the other states. In other words, the good risks must carry the poor ones, which suggests the obvious question — why insure poor risks?

It is my opinion that the agents of bonding companies do not sufficiently investigate the qualifications of contractors for the work they are undertaking before writing a bond, and as far as I have observed, they make no attempt to keep themselves informed as to whether or not a contractor is meeting his obligations during the progress of a contract.

QUESTION: What has been said tonight in regard to the sense of responsibility of the bonding companies has aroused my curiosity on one point. Having in mind the benefits to manufacturing industries through the principle of mutual insurance, I wondered just what consideration might have been given to the application of that principle and to the practicability of applying it, and with what possible measure of success, by a group of responsible and selected contractors?

MR. WASON: I happen to be a director of a mutual insurance company, and I think I can answer your question, at least with respect to Massachusetts. Here the stock companies are so extremely strong that by law for years the mutual companies have been forbidden to do business in this state in surety and fidelity lines. There is possibility that the present Legislature will correct this situation, because for the first time in many years the Insurance Committee is not controlled by stock company brokers. A bill was reported out of committee by a majority of one, and has been enacted and signed by the Governor, to permit mutual companies to write surety and fidelity bonds in this state. In a few of the states mutual companies have broken through and gained the privilege of doing business of this kind — much to the good of the community and to the distress of the stock companies. However, for a great many years, if not forever, the stock companies will do the bulk of the business; therefore their methods must be improved.

COL. FRANK M. GUNBY*

About this surety bond situation — it strikes me that the only parallel I can think of is that it is almost equivalent to trying to run a life insurance business without having a doctor to examine the risk. I don't believe any insurance company would want to go that far.

One thing about the standard form of contract that appeals to me, aside from the reference to the determination of the contractor's standing in the community to which these gentlemen have referred, is that there are about as many forms of contract as there are construction jobs, and the only hope of getting nearer a solution is to get down to

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fewer forms. I presume we must omit for the present at least those contracts which are made up to fit some existing laws. Government or city contracts cannot usually be identical. Before contracts for government or city work can be thoroughly standardized, we will doubtless have to standardize the laws on which they are based. The national government is tackling that phase of the problem at present.

I believe that we in commercial life can get better results if we cut out the vast number of contract forms as they exist and put all our energies into trying to interpret the few types to which commercial practice could be reduced. Then, I believe, it will be very much easier for the contractors, with the government's assistance, to automatically follow suit.

In the Construction Division of the army we operated under one form of contract all through the war. The only change made was to cut down the size of the fee as the war went on. This could be done because every one knew just what was in the contract and knew how it was to be interpreted. Some of these fees amounted to only about $1\frac{1}{2}$ per cent of the cost of the work (by the way, the maximum fee was fixed in all cases). I think that work counts for a good deal in favor of a standard contract.

But I think that the real thought we fellows ought to take home with us is the point General Marshall made, — that engineers as a whole have not been enough interested in the business end of construction. I think we ought to interest ourselves in that side of our work, — the business angle. That element — the one with the dollar sign in it — is common to all contracts I have ever heard of.

OF GENERAL INTEREST

SECTION PRIZES OFFERED

These Should Furnish Incentive to Section Members to Present Papers

About a year ago, the Board of Government of the Boston Society of Civil Engineers voted "to present a prize for a worthy paper given in each section by a member of that section." This action was taken as the result of a recommendation made by the Executive Committee of the Designers Section.

The establishment of these awards fulfills a twofold purpose,—first, it provides the proper recognition of a worthy paper presented before a section by one of its members; and second, it serves as an excellent incentive to members to prepare papers for presentation.

The announcement of these prizes was made early in the summer of last year, and the rules governing the awards were published in the Year Book issued July 15, 1924.

The first award was made at the Annual Meeting on March 25, 1925, to William D. Henderson for his paper on the "Structural Design Features of a Hydro-Electric Development," presented before the Designers Section on February 11, 1925. There were several other excellent papers presented before the Designers Section eligible for the prize, which is limited, however, to one award in each section within a given year. The other sections of the Society do not meet as often as the Designers Section, and there was not sufficient time following the announcement of the establishment of these prizes to provide full opportu-

nity for the securing of eligible papers before the end of last year.

Beginning with the current year there is ample opportunity for section members to prepare papers for presentation at meetings during the fall and early winter. The rules applying to section awards are published herewith, in order to bring them to the attention of the members.

1. The Board of Government shall award annually in each section a prize for the best paper presented during the year, provided that paper is judged worthy of special commendation.

2. The Board shall appoint annually a committee on award for each section, to be composed of three members, one of whom shall be a member of the committee on award of the Desmond Fitzgerald medal, the others shall be members of the particular section involved, and none shall be members of the Board of Government. The appointment shall be made not later than at its regular meeting in June. The committee on award shall recommend to the Board their selection of successful papers.

3. The papers considered shall include all original papers which are submitted in form suitable for publication, by members in all grades of the respective sections, and shall have been accepted by the executive committee of the section or its approved agent, either for publication or for presentation at a meeting. All papers considered shall be presented at a meeting or published during the year ending with the month

of January and no paper shall be eligible which has received, or is to receive, any other award of the Society, or which has previously been contributed to any other association, or has appeared in print prior to its presentation to the section.

4. The committee on award shall report their recommendations to the Board of Government at its February meeting and the awards shall be made by the Board of Government.

5. The announcement of the awards shall be made at the annual meeting.

6. The award shall consist of a book or books of a value not exceeding fifteen dollars, and shall be suitably inscribed on the fly leaf with the name of the recipient, the name and date of presentation of the paper, and the name of the section, together with the fact that it was judged the most worthy paper presented in that section during that particular year. The inscription shall be in handwriting attested to by the president of the society and the chairman of the section. The committee on award shall select the book or books to be awarded, but may consult with the recipient as to his particular desires in the matter.

Are You a Member of a B. S. C. E. Section?

Members of the Society in all grades are eligible for membership in the sections of which there are now four, — Sanitary, Designers, Highway and Northeastern University.

During the past few years these sections have been very active, and a large number of the papers dealing with technical subjects have been presented before them, particularly in the case of the Sanitary and the Designers Sections. Discussion in the sections is always informal, providing an opportunity for the

younger members to commence taking an active part in the Society.

There are no additional dues or fees pertaining to membership in the sections, and a member can join as many of them as he desires.* All that is necessary is to send your name to the clerk of the individual section or to the Secretary of the Society at 715 Tremont Temple, Boston, requesting that you be enrolled on the membership list of the section. The By-laws of the sections are published in the Year Book for 1924-25.

Precise Levels at Springfield, Mass.

In connection with an article on "Precise Leveling in New England," in the September, 1924, JOURNAL of the Boston Society of Civil Engineers, a list was published giving the Descriptions and Elevations of Permanent Bench Marks between Portland, Me., and Providence, R. I., which included numerous bench marks in the vicinity of Boston. These were established by the U. S. Coast and Geodetic Survey in 1923. At that time a tie line was run from Hartford, Conn., to Springfield, Mass.

The following bench marks were established in the vicinity of Springfield. It is believed that members of the Society in the western part of the State may find this information of use. Two of the bench marks in the accompanying list are identical with those of the Van Orden line of levels which was run from Boston to Albany, a description of which is included in the Report of the Commissioners of the Topographical Survey (of Massachusetts) for the year 1893.

BENCH MARKS NEAR SPRINGFIELD, MASS.

Datum is Mean Sea Level

A. — About $4\frac{3}{4}$ miles south of **Springfield**, Hampden County, 204 feet east of the east rail

* Membership in the Northeastern University Section is limited to students, graduates or faculty members of the Northeastern University.

of the New York, New Haven & Hartford Railroad at the Longmeadow depot, in the top at the south end of a masonry highway culvert, 4 feet south of a fence. A brass disk. (16.979 meters or 55.705 feet).

B. — About $1\frac{1}{2}$ miles south of **Springfield**, Hampden County, on the New York, New Haven & Hartford Railroad, 75 feet north of bridge No. 60.07 carrying South End Street over the railroad and the Connecticut River, 105 feet east of the east rail and 7 feet north of a fire plug. A concrete post with disk in top. (18.314 meters or 60.085 feet.)

C. — At **Springfield**, Hampden County, one block west of the Union Station, set horizontally in the top of the sandstone parapet north of the tracks over the Main Street arch, 3 feet west of the highest part of the parapet. A brass disk. (26.114 meters or 85.676 feet.)

D. — At **Springfield**, Hampden County, in the easterly municipal building facing Court Square, in the building foundation on the east side of the stairway structure, 6 feet from the south wall and 2 feet above the sidewalk. A brass disk. (21.219 meters or 69.616 feet.)

City B. M. — At **Springfield**, Hampden County, in the iron base of a column at the southwest corner of the Gilmore Building on the north side of State Street. A filed mark in the iron. (20.854 meters or 68.418 feet.)

Van Orden C. P. 1. At **Springfield**, Hampden County, on the Main Street bridge at the west end of the depot, west of the north arch. The west end of the highest point of a hole. (26.004 meters or 85.315 feet.)

Van Orden B. M. 63. At **Springfield**, Hampden County, at the east end of the north abutment of the St. James Avenue bridge, on the southeast corner of the second bottom stone. A hole marked "B." (59.891 meters or 196.492 feet.)

Memorandum on Periodical Indexes

Members using the library of the Society are often particularly interested in articles published in periodicals and in transactions of engineering societies. Sometimes reference to current material is sought, but in other cases it is desired to obtain all the available information which has been published within a period of several years on some specific subject.

Much time is wasted on a search of this kind unless the proper means are at

hand. In order to facilitate this work the library maintains the two indexes best suited for the purpose, — the Engineering Index and the Industrial Arts Index. From these sources it is a simple matter to obtain the desired references. Many of the references will be to publications regularly maintained in bound volumes at the Society library. In cases articles referred to are in publications not kept at the library, they are generally available for study at other libraries in the vicinity, and if desired the volumes can be obtained by our library through our exchange relations.

In order to familiarize those of our members not already acquainted with these indexes the following memorandum concerning them has been prepared.

The **ENGINEERING INDEX**, now published by the American Society of Mechanical Engineers, is the oldest periodical index devoted wholly to engineering literature, going back to 1884 in an unbroken series, of which this library has a complete file. The articles indexed in the 1924 volume were selected from over 1,300 periodicals and reports, including many publications in foreign languages. The arrangement is alphabetical by subject, with broad general headings, and a brief abstract or commentary is included with each reference.

The index was issued in four cumulative volumes covering the period from 1884 to 1905, with an annual volume since 1906, which is continued currently in "*Mechanical Engineering*," published by A. S. M. E. This monthly index refers chiefly to items of interest to the mechanical engineer, but the annual cumulation deals also with civil, electrical, mining, and other branches of engineering.

The **INDUSTRIAL ARTS INDEX**, of which we have also a complete file, was begun in 1913 with annual volumes to date, and biennial cumulations every other year since 1919. While covering many of the same periodicals, it differs from the Engineering Index in several respects, viz.:

1. It has a wider scope, covering commercial and economic subjects as well as technology.

2. Its headings are less general, with many subdivisions, and more specific entries for special processes, etc.

3. It covers chiefly articles published in English, although the later volumes include some foreign journals.

4. It is issued monthly, cumulating quarterly, annually, and biennially.

Quantities of Materials for Concrete

A second edition of Bulletin 9 of the Structural Materials Research Laboratory, Lewis Institute, Chicago, "Quantities of Materials for Concrete," by Duff A. Abrams and Stanton Walker, has been issued.

The principal subject-matter of the Bulletin is a series of tables of proportions and quantities for Portland cement concrete for compressive strengths of 2,000, 2,500, 3,000, 3,500, and 4,000 pounds per square inch at twenty-eight days, using fine and coarse aggregates of different sizes, and concrete of a wide range of workability as measured by the slump test.

The tables are based on the water-ratio method of proportioning concrete developed in this Laboratory as a result of many thousands of tests. They differ principally from tables by other authors in that the proportions have been selected with definite strengths in view, and take into account the quantity of mixing water as well as the size and grading of the fine and coarse aggregates.

This Bulletin was first published in 1921, but has been out of print for several months. In the second edition, the text has been rewritten to constitute a more complete discussion of the subject. A method of taking into account the differences in volumes of materials when measured in the Laboratory and when measured under field conditions is described. The descriptions of field and laboratory test methods have been enlarged and include recent changes in the Standards of the American Society for Testing Materials.

This Bulletin has recently been received at the library of the Boston Society of Civil Engineers. Additional copies may be obtained upon application to the Structural Materials Research Laboratory, Lewis Institute, Chicago.

PROCEEDINGS OF THE SOCIETY

MINUTES OF MEETINGS

DESIGNERS SECTION

MAY 13, 1925. — The regular May meeting of the Designers Section of the Boston Society of Civil Engineers was called to order at 6.10 P.M. in the Affiliation Rooms. The minutes of the April meeting were read and accepted.

The chairman introduced Mr. Charles M. Emerson, New England manager of the Fairchild Aerial Surveys, Inc. Mr. Emerson gave a very interesting talk on "The Engineer Takes Wings," illustrating his talk with a number of lantern slides. A stereoscope with the necessary photographs was then set up and the members given an opportunity to see how differences in elevations may be observed.

There were 31 members and visitors present. The meeting was adjourned at 7.15 P.M.

SCOTT KEITH, *Clerk.*

APPLICATIONS FOR MEMBERSHIP

[June 15, 1925]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

For Admission

GILCREAS, FRANK WELLINGTON, Newton, Mass. (Age 31, b. Belmont, Mass.) Graduate of Harvard University in 1916. From 1916-17 chemist at Massachusetts State Infirmary; 1917-24, assistant chemist and water analyst, New York State Department of Health; from April,

1924, to date, chemist with Weston and Sampson. Refers to G. G. Bogren, E. S. Chase, S. E. Coburn, F. L. Preble.

ZAPOLSKI, WALTER WADSWORTH, New York, N. Y. (Age 24, b. Warsaw, Poland.) Graduate of Massachusetts Institute of Technology, 1923; 1923-24 assistant engineer on general engineering work; from June, 1924, to September research engineer with Mason & Hamlin; September, 1924, to February, 1925, on power plant construction; from March, 1925, to May with the Board of Transportation as structural designer on New York subways; from May, 1925, to date, with the Knickerbocker Ice Company as designer on steel and concrete manufacturing plants. Refers to J. B. Babcock, C. B. Breed, H. L. Bowman, C. E. Breitbeil, Eugene Mirabelli, C. M. Spofford.

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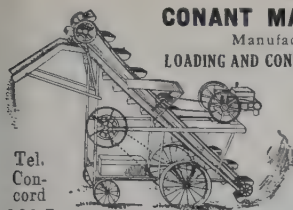
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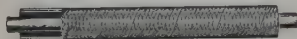
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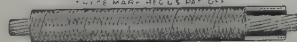
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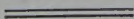
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American Institute of Mining and Metallurgical Engineers, 29 West 39th Street, New York.
American Society of Civil Engineers, 33 West 39th Street, New York.
American Society of Mechanical Engineers, 29 West 39th Street, New York.
Brooklyn Engineers' Club, 117 Remsen Street, Brooklyn, N. Y.
Cleveland Engineering Society, Hotel Winton, Cleveland, Ohio.
Detroit Engineering Society, Detroit Board of Commerce Building, Detroit, Mich.
Engineering Association of Nashville, Chamber of Commerce Building, Nashville, Tenn.
Engineering Institute of Canada, 176 Mansfield Street, Montreal, Canada.
Engineers' Club of Baltimore, So. East cor. Light and Redwood Streets, Baltimore, Md.
Engineers' Club of Dayton, cor. Monument Avenue and Jefferson Street, Dayton, Ohio.
Engineers' Club of Kansas City, Room 509, K. C. S. Building, Kansas City, Mo.
Engineers' Club of Philadelphia, 1317 Spruce Street, Philadelphia, Pa.
Engineers' Club of St. Louis, 3817 Olive Street, St. Louis, Mo.
Engineers' Club of Toronto, 96 King Street, West Toronto, Canada.
Engineers' Society of Pennsylvania, 31 South Front Street, Harrisburg, Pa.
Engineers' Society of Western Pennsylvania, William Penn Hotel, Pittsburgh, Pa.
Louisiana Engineering Society, State Museum Building, Jackson Square, New Orleans, La.
Montana Society of Engineers, Butte, Mont.
Pacific Northwest Society of Engineers, 803 Central Building, Seattle, Washington.
Rochester Engineering Society, 131-135 Sibley Building, Rochester, N. Y.
Technology Club of Syracuse, Vinney Building, Syracuse, N. Y.
Vermont Society of Engineers, Montpelier, Vt.
Western Society of Engineers, 1735 Monadnock Block, Chicago, Ill.

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